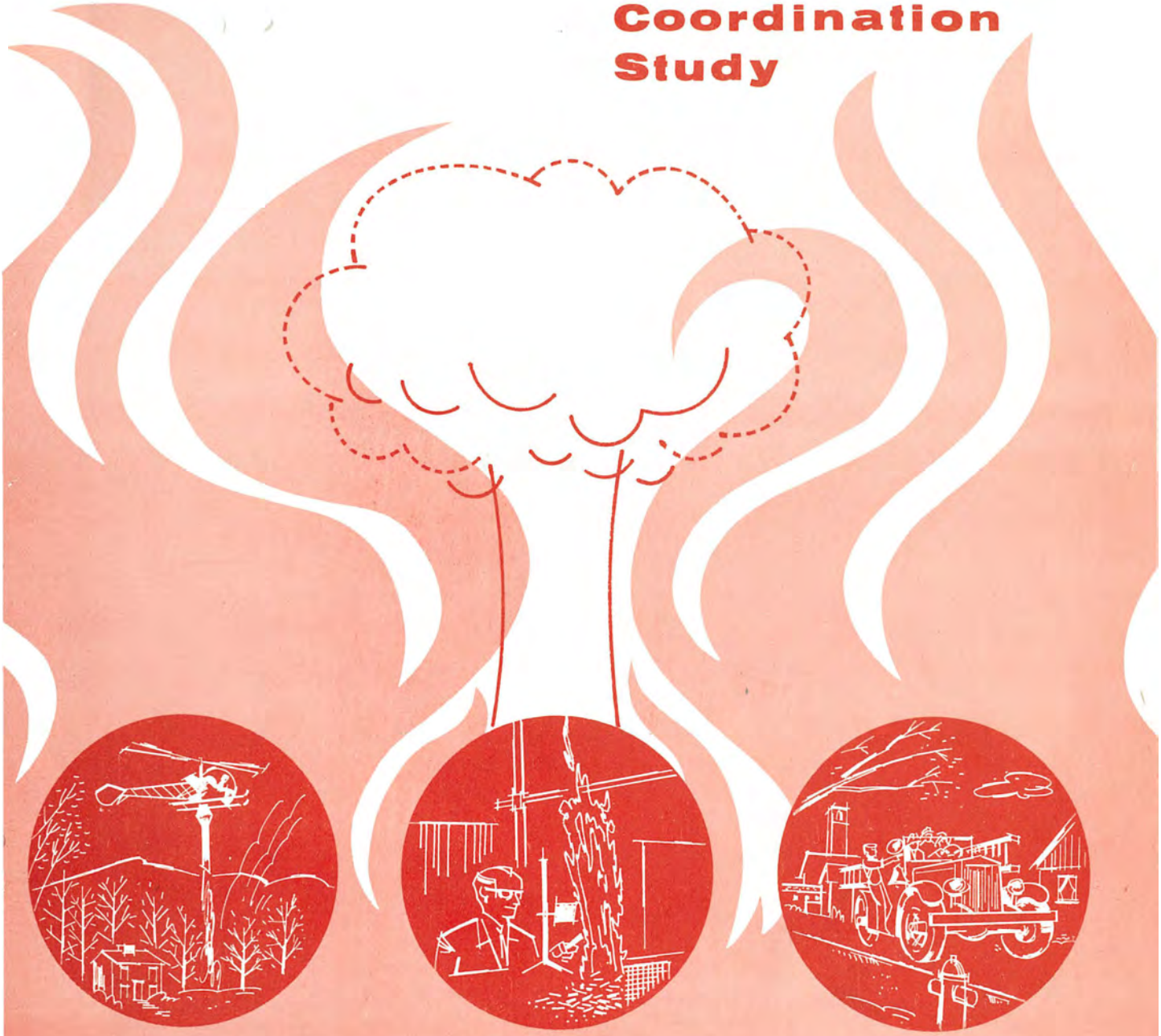
BOSTON FIRES

National Fire Coordination Study



U.S. DEPARTMENT OF AGRICULTURE/FOREST SERVICE/DIVISION OF FIRE CONTROL

BOSTON FIRES

- A study of four large fires and a projection of their threat to life and resources had they occurred during a nuclear attack.

A Working Paper Prepared

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BOSTON FIRES

INTRODUCTION

Background work for the National Fire Coordination Study, Project 229, calls for the study of large fires in urban areas, and in areas where the settlement pattern is mixed urban and rural. These studies are designed to search out factors important to better utilize Federal, state, local, and private fire organizations in effective control of mass fires resulting from natural causes or from an enemy attack.

Most peacetime fires in urban areas are far from being representative of the fires that might result from an enemy attack. However, they provide a realistic set of circumstances for evaluating the ultimate threat to the people and resources in the immediate area where the fires occur, thus providing some measure of what might be accomplished through the efforts of an organized fire service.

One of the major findings in the Analytical Report[1/] was that fire would be a significant causative agent in the loss of lives and resources in a nuclear attack. With the population in residences,

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1/ Analytical Report, by W. R. Moore, J. W. Jay, J. H. Dieterich. NFCS, FS, Mar. 1965

fire would be less significant since a larger percentage of the people would loose their lives as a result of blast and fallout. Conversely, with shelters available and occupied, more people will survive the immediate effects of blast and the longer term effects of radioactive fallout. They would then be threatened by the fires that would result from the thermal effects of the weapons or the secondary ignitions caused by blast damage.

With these considerations in mind it was decided to study four recent large urban fires that have occurred in Metropolitan Boston, and assess these fires in terms of what can be learned and applied to the objectives of the National Fire Coordination Study. This study of the Boston fires was not made for the purpose of reevaluating the fire suppression strategy or tactics, or effectiveness of mutual aid response. Listed below are four fires that were examined:

1. The Bellflower Street Fire, May 22, 1964
2. The Codman Square Fire, October 12, 1963
3. The Morgan Memorial Goodwill Industries Fire, October 12, 1963
4. The Charlestown Fire (Potato Sheds Fire) May 10, 1962

Figure 1 is a map of the Boston area showing where the fires were located in relation to the city center, and in relation to each other.

STUDY OBJECTIVES

The main objectives of this Boston fire study are to project the case histories of these fires into conditions of fallout created by an assumed nuclear attack; and examine the resultant fire threat and demands on the fire services with particular emphasis on the problem of defending fallout shelters from fire. More specifically, the following points were considered:

1. What effective fire suppression action could be accomplished in a one-hour period before critical radioactive fallout arrived?

2. What is the fire threat to a sheltered population in areas adjacent to the fire?

3. Would multiple ignitions caused by the thermal flash create a situation that could be handled in the first hour - handled at all?

4. Would evacuation be possible or desirable under the assumed conditions of attack?

5. How far would the fire be expected to spread before being stopped by natural barriers?

6. Could fire control priorities be established to limit fire development in certain areas?

Figure 1. Location of 4 study fires in Metropolitan Boston.

DESCRIPTION OF BOSTON URBAN FUELS

Boston is recognized as one of several large cities in the United States having a major conflagration potential[2/]. In 1929 the National Fire Protection Association prepared a map of Boston, and surrounding boroughs, showing the potential conflagration areas. The map outlined the areas where building densities exceeded 20% (ratio of roof to ground) over large areas. If, for instance, the buildings were three or four decker tenement houses the potential would be increased; if they were old and poorly maintained, the problem would become even more critical. A similar map prepared today would probably show only minor changes in the overall picture. Recent redevelopment projects and urban renewal have converted some of the potentially bad areas to a tolerable level of fire susceptibility. New access highways and freeways have provided some relief from the large continuous blocks of urban fuels but large areas of critical fuels remain.

2/ Report Memo on meetings with National Fire Protection Association, by J. H. Dieterich, Oct. 22, 1964

An article in the NFPA Quarterly emphasizes the conflagration threat that exists in the South End and Roxbury Sections of the city[3/]. Since 1958 when the article was written, much successful redevelopment work has been accomplished on a city-wide basis, and work is continuing in nearly all parts of the city. Urban renewal is a step toward fuel conversion projects that will eventually reduce the chances of conflagrations. However, in the meantime, the Boston Fire Department must continue to fight these difficult fires where spacing, construction, and exposure of the buildings are so important. (Fig. 2) They have been successful in handling the fires in these difficult urban fuel types because they have recognized the conflagration potential and have been able to adapt their suppression tactics to each individual situation.

GENERAL ASSUMPTIONS

The following assumptions were made to help project these fires into conditions that might prevail during a nuclear attack:

1. Using actual weather conditions; consider each fire individually and assess the immediate fire threat that would result if only one hour of effective firefighting were possible before critical levels of radioactive fallout arrived. With mutual aid; and without mutual aid.

3/ Boston's Blighted Boroughs, by B. M. Hermes, NFPA Quarterly, Jul. 1958.

Figure 2. Urban fuels such as this tenement complex makes firefighting difficult and increases the chances of a conflagration.

2. Assess the immediate threat if the four fires had occurred simultaneously and there was only one hour of effective firefighting time available before fallout arrives, with mutual aid; without mutual aid.

3. Assume available shelter spaces are occupied when the fires occur.

4. Assume that the fire services are in a regular state of readiness and have not called in off-duty firemen.

STUDY FIRES

Bellflower Street Fire, May 22, 1964[4/]

General: This fire occurred in a congested Boston neighborhood made up mostly of well-kept, three-story, wood frame tenements. (Fig. 3) The streets are narrow and the houses are spaced closely together causing serious exposure problems. Starting at 1:38 pm on the wooden back porch of a second-story unit, the fire spread quickly to involve adjacent buildings.

Below normal rainfall had been experienced for about a month prior to the fire, and on the day of the fire, the wind was 27 mph from the southwest with gusts up to 39 mph; the temperature was 76° ; the relative humidity 37% (dry); and the sky was overcast.

4/ Dwelling Conflagration, Boston, Mass. - NFPA Quarterly Oct. 1964

Figure 3. Flames Sweep South Boston Tenements
Air view on May 22, 1964, showing flames and smoke from fire sweeping through wooden homes in crowded section of South Boston.

The fire was controlled at 4:45 pm, 3 hours 15 minutes after it started. There were a total of 70 fire and rescue companies used on the fire, 28 of which were mutual aid units from nearby communities[5/].

The official report on the fire prepared by the Boston Fire Department is on file in the NFCS Library[6/].

Shelters: Figure 4 is a map of the Boston area where the Bellflower Street Fire occurred. The fire location is indicated on the map and the Standard Location's (SL's) are outlined that form the basis for summarizing Civil Defense shelter facilities and population in the area. Table 1 summarizes the number of facilities, licensed shelter spaces, and population for both day and night. Also shown are the shelter spaces needed, or in excess, during the day and night.

5/ Boston's "Three-Decker" Fire, NFPA Fireman, Jul. 1964

6/ Official Report of the Bellflower Street Fire, by J. E. Clougherty, Boston Fire Department, May 22, 1964

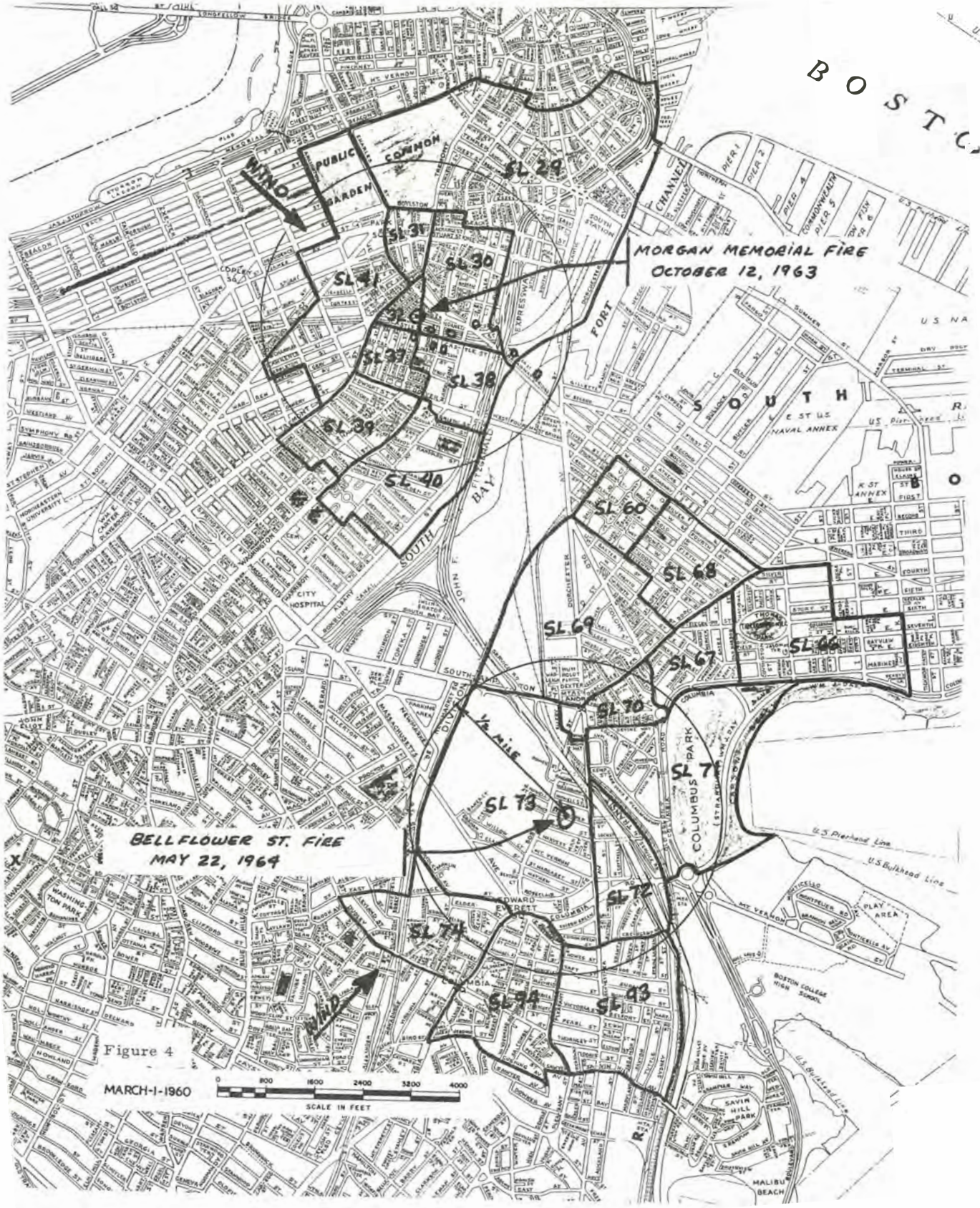
MORGAN MEMORIAL FIRE
OCTOBER 12, 1963
BELLFLOWER ST. FIRE
MAY 22, 1964
SL 29
SL 30
SL 31
SL 32
SL 33
SL 38
SL 39
SL 40
SL 41
SL 60
SL 68
SL 69
SL 66
SL 67
SL 70
SL 71
SL 72
SL 73
SL 74
SL 93
SL 94
PUBLIC GARDEN
COMMON
SOUTH BAY
CITY HOSPITAL
COLUMBUS PARK
1/8 MILE
MARCH-1-1960
0 800 1600 2400 3200 4000
SCALE IN FEET

Figure 4

Table 1

Population and Shelter Space Summary *

(Bellflower Street Fire)

SL No.	No. Facilities	Licensed Spaces	DAYTIME Population	DAYTIME Shelter Balance	NIGHTTIME Population	NIGHTTIME Shelter Balance
73	1	168	5,332	5,164-	6,505	6,337-
70	0	0	1,508	1,508-	1,298	1,298-
71	11	968	3,189	2,221-	2,898	1,930-
60	27	4,061	3,405	656+	3,727	334+
68	4	2,113	5,549	3,436-	3,296	1,183-
69	2	3,962	2,164	1,798+	851	3,111+
67	21	3,015	3,745	730-	4,470	1,455-
66	4	2,364	6,274	3,910-	6,312	3,948-
74	1	1,430	2,983	1,553-	3,311	1,881-
93	1	155	5,702	5,547-	6,422	6,267-
94	2	520	4,263	3,743-	3,679	3,159-
72	0	0	1,630	1,630-	1,529	1,529-
Totals	74	18,756	45,744	26,988-	44,289	25,542-

* A Shelter Assignment and Utilization Plan for Boston, Mass. Dec. 31, 1963. Boston Office of Civil Defense.

The summary shows that there are 74 facilities within the Standard Location's indicated on the map having licensed shelter spaces for 18,756 people. The total daytime population is 45,744 making a deficiency of 26,988 available shelter spaces. The situation is nearly as bad at night when there is a shortage of shelter spaces totalling 25,542.

A sample of the designated fallout shelters in this area were visited to determine the relative degree of fire vulnerability. The most effective shelters visited appeared to be in a public housing area on Burke Street and Carmody Court. These were three-story brick buildings with fire-resistant roofing. Although there were wood frame windows, the yards were clear and there was good spacing between buildings and across streets. Two schools were checked for external fire vulnerability. Because of construction and exposure it was evident that both would be extremely difficult to defend if fire were moving into the area.

Fire Threat: Assuming that only one hour of fire suppression action would have been possible prior to the arrival of radioactive fallout, it appears likely that all the shelter spaces in the Standard Location's located downwind and laterally from the point of fire origin would have been exposed to a spreading fire. Upwind, the fire would have spread more slowly and radiation would probably have caused the fire to spread across the narrow streets into the wind. Major streets or freeways would have been effective in stopping the fire as it spread into the wind.

It was the considered opinion of the local fire services that, had only one-hour been available to extinguish this fire occurring from a single ignition, control would not have been possible and the fire would have jumped the major freeway indicated on the map and spread on toward the NW.

Conclusions:

a. Prompt action on the part of citizens might have prevented this fire. A bucket of water would likely have extinguished the fire in the very early stages.

b. Multiple ignitions in this area would call for prompt evacuation of all citizens, because if only two or three fires were permitted to develop, the entire community would be threatened.

c. The 600-foot wide J. F. Fitzgerald Expressway would not have made an adequate firebreak ahead of the fire if the fire had been permitted to burn with only limited control action.

Morgan Memorial Goodwill Industries Fire, October 12, 1963

General: This fire occurred at 11:37 am in a group of vacated buildings being prepared for demolition to make way for a new expressway[7/]. Strong NW winds and low humidity caused the fire to develop so rapidly that one of the multi-storied brick wood-joisted buildings was completely involved when the first fire alarm arrived. Within 5 minutes five alarms had been sounded to call in 19 engine companies, 5 ladder companies, and the rescue squad. Within 10 minutes from the time the fire started it was evident that spot fires would develop as a result of wind-borne brands and additional equipment was dispatched to meet this situation. Spot fires started in at least five large buildings, in railroad ties in a depressed railroad right-of-way and in two abandoned warves nearly four blocks away.

7/ Simultaneous Boston Fires, NFPA Quarterly, Apr. 1964.

Between 11:37 am and 5:54 pm nearly every Boston Fire Company was involved in responding to this fire and 69 additional non-related routine fires and emergency requests.

Shelters: Refer again to Figure 4, a map of the downtown Boston area showing the location of the fire and associated spot fires. Standard Location's are also indicated by number so that the reader can identify shelter space availability from Table 2. A review of Table 2 indicates that there are 211 shelter facilities available in the indicated SL's having licensed shelter spaces for 348,764 people. The daytime, or working population in this area, totals 233,350 leaving a surplus of 115,414 shelter spaces during daytime working hours and a 333,002 surplus at night. There are ample shelter spaces in SL No. 29 alone to provide some measure of protection for the entire daytime population within the indicated SL's. This might suggest that, if possible, people from nearby SL's, where shelter spaces are inadequate, should attempt to move into the downtown area to reach shelter. However, if an attack on the city's center were expected, such a move might not be for the best.

Table 2

Population and Shelter Space Summary *

(Morgan Memorial Goodwill Industries Fire)

SL No.	No. Facilities	Licensed Spaces	DAYTIME Population	DAYTIME Shelter Balance	NIGHTTIME Population	NIGHTTIME Shelter Balance
41	17	36,470	26,900	9,570+	3,815	32,655+
31	15	22,101	9,800	12,301+	280	21,821+
30	19	16,393	25,100	8,707-	2,515	13,878+
37	0	0	2,550	2,550-	1,934	1,934-
38	1	51	3,200	3,149-	329	278-
29	150	270,509	151,250	119,259+	700	269,809+
32	1	905	3,150	2,245-	333	572+
39	0	0	5,500	5,500-	2,928	2,928-
40	8	2,335	5,900	3,565-	2,928	593-
Totals	211	348,764	233,350	115,414+	15,762	333,002+

* A Shelter Assignment and Utilization Plan for Boston, Mass. Dec. 31, 1963. Boston Office of Civil Defense.

The shelter facilities in this area are located for the most part in large office buildings, commercial establishments, and in the subway system. Some of these buildings are undoubtedly more vulnerable to fire than others, but it is safe to assume that fires could not be permitted to burn in downtown Boston without posing a serious threat to other buildings in the area. We were unable to determine what proportion of the available shelter spaces listed in Table 2 might be located in the Boston Subway System. These spaces would provide some of the safest locations, provided adequate ventilation was maintained.

Fire Threat: Boston fire service personnel stated that control of this fire within one hour would have been impossible. Assuming the one-hour time limit on suppression action, it was evident a number of shelter spaces downwind would be immediately threatened by fire, and eventually the build-up area in SL No. 29 would also be threatened by the fire backing into the wind after control action had to be terminated because of fallout. The large concentration of shelter spaces in SL No. 29 are located laterially or upwind from the ignition point and spread to that area would have been relatively slow unless there would have been a shift in wind direction.

The fire spotted downwind to the channel nearly four blocks away to ignite an old warf. If the fire had been permitted to burn, it might have spread on across the Fort Point Channel to threaten the entire South Boston area.

Conclusions:

a. With the weather conditions prevailing at the time, it would have been impossible to completely rely on expressways or narrow bodies of water to halt the spread of the fire.

b. Even with most of the shelter spaces located up-wind or laterially from the fire origin, the character of the fire indicated that it would have eventually threatened the concentrated shelter areas - probably during the period when fallout would be most critical.

Codman Square Fire, October 12, 1963[7/]

General: The Morgan Memorial Fire, just described, had been burning about 2 hours and 40 minutes when this alarm was sounded. This fire originated in a store approximately 10 miles from the Morgan Memorial Fire and was controlled in about 3 hours and 40 minutes. Three large, three-story tenement houses eventually became involved. By itself, this was not considered a difficult fire, but because of the other current fire activity in the city a problem did develop. Many of the mutual aid companies were called in to report directly to the fires in progress rather than being used to cover vacant fire stations.

7/ Simultaneous Boston Fires, NFPA Quarterly, April 1964

Boston has a long history of effective mutual aid arrangements between the various cities and towns in the greater Boston area[8/]. The mutual aid response on October 12th to help control the going fires and provide support for the units in action increased the size of the Boston Fire Department by one third.

Shelters: Figure 5 is a map of the Codman Square area in the Dorchester Sector of Boston where the fire occurred. Standard Location's are indicated by number, and the fallout shelter summary for the area is indicated in Table 3. Only 10 shelter facilities having a total of 5,478 licensed spaces were available in this area when the survey was made in 1963. This left a shelter space deficit of 33,242 in the daytime and 36,609 spaces at night. Obviously, these people would need to seek shelter in other areas if they expected to find fallout protection.

8/ The Boston Fire Department, by W. Y. Kimball, NFPA Fireman, Aug. 1952

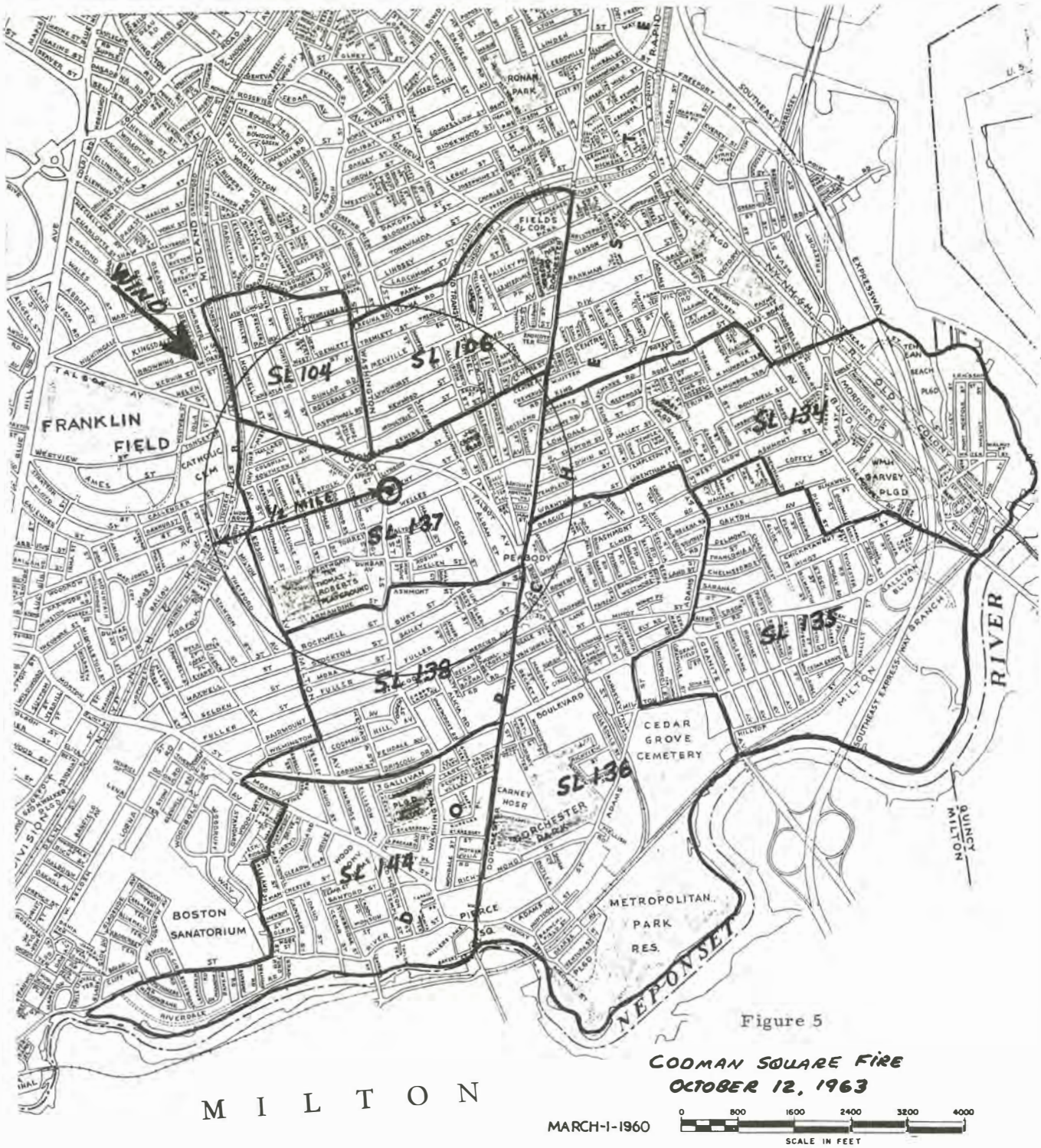

Figure 5

COOMAN SQUARE FIRE
OCTOBER 12, 1963

Table 3

Population and Shelter Space Summary *

(Codman Square Fire)

SL No.	No. Facilities	Licensed Spaces	DAYTIME Population	DAYTIME Shelter Balance	NIGHTTIME Population	NIGHTTIME Shelter Balance
137	4	1,247	7,509	6,262-	7,632	6,385-
104	1	191	4,745	4,554-	6,038	5,847-
106	1	116	4,262	4,146-	4,342	4,226-
138	1	248	4,539	4,291-	5,518	5,270-
134	1	158	10,065	9,907-	9,389	9,231-
136	2	3,518	7,600	4,082-	9,168	5,650-
Totals	10	5,478	38,720	33,242-	42,087	36,609-

* A Shelter Assignment and Utilization Plan for Boston, Mass. Dec. 31, 1963. Boston Office of Civil Defense.

The fallout shelter facilities in this area were not specifically visited as they were for the two fires previously discussed but again, as in the Bellflower Street region of Dorchester the shelter facilities were located primarily in schools and public buildings. Because of the construction of the shelter buildings and exposure of the surrounding residential areas, most of the shelter spaces appeared to be vulnerable to fire.

Fire Threat: Boston Fire Service personnel stated that of the four study fires, this fire would have come the closest to being controlled within the simulated one-hour allotted time. Even though control was not achieved for nearly four hours, they felt that enough effective work might have been done in one hour to prevent the fire from spreading. They felt also that if there had been no other fires burning in the city, control would have been achieved without mutual aid.

The population in the 6 Standard Location's shown in Figure 5 is approximately 40,000, and shelter spaces are available for only about 13% of the population. Because of the character of the shelter facilities, most of these available spaces would be threatened if fires were burning uncontrolled in the area.

This means then, that if fires were expected in the area, the people in the threatened shelters should be removed to another area; and a mass evacuation operation would be necessary to protect the remainder of the population that would be threatened by fallout.

With the NW wind prevailing there are no major breaks ahead of this fire that could be expected to stop the spread before the fire reached the park areas and expressways along the Neponset River. The river is about 1 - 1 1/2 miles from where the fire started and would provide the best available natural break to stop the fire.

Conclusions:

a. Even with adequate warning the combination threat of fallout and fire in this area might indicate the need for immediate, total evacuation.

b. Multiple ignitions in this area on a bad fire day would make one-hour control difficult, if not impossible, for all available regular and mutual aid fire forces.

c. In areas such as this where there is a heavy build-up of urban fuels and inadequate natural barriers, the threat from fire might make full use of fallout shelter spaces impractical.

Charlestown Fire, May 10, 1962[9/]

General: This fire started at about 4:00 pm under a loading platform in the freight yards of the Boston and Maine Railroad. Within five minutes the fire had spread to the first of several potato storage sheds that were eventually to become involved. Located adjacent to the storage sheds, in addition to several residences, were 31 freight cars, approximately 25 tractor-trailer units, and a four-story brick warehouse used to store cooking fats and baking supplies.

The weather had been dry for several days preceding the fire. On the day of the fire the humidity was low and the wind was from the NW at 22-38 mph. The wind was blowing nearly parallel to the railroad siding and down the line of storage sheds.

The railroad yards are slightly recessed below the general level of Lynde Street which paralleled the tracks to the north. The back yards and porches of several dwellings facing on Washington Street were exposed to the developing heat. In a short time several of these dwellings became

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9/ The Potato Sheds Fire, Official Report on Charlestown Fire of May 10, 1962. Boston Fire Department

involved. If fire had continued to spread from these buildings it would have threatened a large portion of southeast Charlestown.

The fire eventually burned nearly 2,000 feet of storage sheds, the four-story brick warehouse, several freight cars, and parts of several dwellings on Lynde and Washington streets. The responding units were handicapped from the beginning by the rush-hour traffic that filled the main routes leading to the fire and moved even more slowly to get a better look at the fire area.

Approximately 480 men from the Boston Fire Department, mutual aid cities and towns, Boston Navy Yard, Bedford Air Force and Civil Defense worked on this fire before it was declared out on the following day at about 5:00 pm. Inadequate water supply, high winds, inaccessibility, and exposure of nearby structures all contributed to difficulty of control.

Shelters: Figure 6 is a map of the Charlestown area showing where the fire occurred and the Standard Location's for summarizing shelter spaces. Table 4 lists 14 facilities having a total of 5104 licensed shelter spaces. This borough, although not as heavily populated, has much the same problem as the Dorchester and South End areas concerning shelter space availability and vulnerability of the existing shelter facilities.

We looked at several representative shelter facilities in the Charlestown area and found the majority of the spaces were in SL No. 16 in public housing projects owned by the city of Boston. The buildings are mostly three-story brick with built-up roofs and either metal casement or wood frame windows. Yards and streets provide some measure of protection from a spreading fire, and it might be possible for fire guards to protect these buildings from within to prevent fire from threatening the basement shelters. There was a school building with designated shelter spaces that would have been difficult to defend from fire, but a YMCA building located away from other buildings might afford some degree of protection from fire.

EVERETT
ISLAND END R.
MYSTIC RIVER
CHARLESTOWN
CHELSEA
U.S. Pierhead Line
MYSTIC WHARF
TERMINAL
LITTLE MYSTIC CHANNEL
MYSTIC PIER No. 1
BOSTON INNER HARBOR
UNITED STATES NAVY YARD
WIND
SL 16
SL 15
SL 21
SL 22
SL 23
1/2 MILE
CHARLESTOWN FIRE
MAY 10, 1962
MARCH-1-1960
0 800 1600 2400 3200 4000
SCALE IN FEET

Figure 6

Table 4

Population and Shelter Space Summary *

(Charlestown Fire)

SL No.	No. Facilities	Licensed Spaces	DAYTIME Population	DAYTIME Shelter Balance	NIGHTTIME Population	NIGHTTIME Shelter Balance
21	0	0	2,000	2,000-	2,833	2,833-
22	2	524	2,000	1,476-	2,383	1,859-
16	8	4,236	3,000	1,236+	4,187	49+
15	4	344	1,500	1,156-	2,518	2,174-
Totals	14	5,104	8,500	3,396-	11,921	6,817-

* A Shelter Assignment and Utilization Plan for Boston, Mass. Boston Office of Civil Defense. Dec. 31, 1963

Fire Threat: This is another area of critical urban fuels in Metropolitan Boston where fires must be controlled when they are small because of the potential for conflagration development.

It would have been impossible to control this fire within the one-hour allotted time, and without any additional control action, the fire would likely have spread with the wind through southeast Charlestown and into the U. S. Navy Yard. Moving laterally by radiation, the fire would have threatened virtually all of Charlestown north of the Mystic River. Boston Inner Harbor and the Charles River should have provided an adequate break on the south and southeast.

The overall character of Charlestown is not likely to change to any large extent over the next few years. Some urban renewal may occur as it has in other areas, but unless major changes are made the conflagration threat will remain.

Conclusions:

a. Even with an immediate response by the fire services, this single ignition developed sufficiently to threaten most of Charlestown.

b. Multiple ignitions in this area, under these weather conditions, would probably result in such rapid development of mass fires that evacuation would be difficult.

c. Charlestown, like Dorchester and Roxbury, is a potential conflagration area. If small fires are not extinguished or if primary ignitions are too numerous to be effectively controlled by the fire services and the citizens, virtually the entire community would be threatened by fire.

Simultaneous Occurrence of Study Fires

Under "General Assumptions" stated earlier we proposed to assess the immediate threat if the four fires had occurred simultaneously; and there was only one hour of effective firefighting time available before fallout arrives.

It seems evident after reading the previous discussions of the individual fires that, had these four fires occurred at nearly the same time and under any of the stated weather conditions, control within one hour would have been unlikely. Even with the excellent mutual aid arrangements in effect in the Boston area, the combined efforts would probably not have been successful in controlling the fires in the short time available. The consequences of four such uncontrolled fires in the Boston Metropolitan area would be (1) the destruction by fire of vast areas of industrial and residential developments, and (2) to threaten fallout shelters in a large part of the city.

OBSERVATIONS

1. The effects that nuclear fallout would have on firefighting capabilities is not recognized nor understood by the public or by the fire services.

2. The Boston Fire Service personnel interviewed were reluctant to recognize they might need to seek shelter after an hour of fighting fires. They maintained that in accordance with previous training and policy they would probably continue to fight the fire in the face of fallout.

3. The theory that nuclear weapons could cause initial ignitions within even a limited radius out from ground zero is not fully accepted.

4. There seems to be a need for a better understanding of (a) the effects of nuclear fallout, and (b) the fire problem that might result from an enemy attack.

5. If fallout shelters were in the path of a fire that could not be controlled within a one-hour period, the fire services felt that the shelters should be evacuated, but that they should not be the ones to do the job because they would be busy with the fires. Evacuation would be either by police or independent action.

6. Fallout shelter distribution is a critical problem in a city like Boston. There appears to be adequate shelter spaces (not necessarily stocked) for the daytime, downtown, working population. The problem would be to provide for complete utilization of the available spaces.

7. Critical fire weather appears to be associated with many of the large urban fires in Metropolitan Boston. The structural characteristics of the city seems to encourage a response to fire weather changes in much the same way as wildland fuels.

8. Chief Clougherty believes that even the most intensive of fire prevention education programs cannot guarantee a continued reduction in the number of fires. He emphasized the need for increased fire protection through research to develop methods, materials, and procedures to make it increasingly more difficult for the public to cause fires accidentally or intentionally.

9. Citizen action could be effective in extinguishment of small ignitions immediately after a nuclear attack and before taking shelter from fallout. To be effective, education and training would be required.

10. A thermal flash in some areas of Boston could cause so many fires that only selective control action would be feasible.

11. Current fire control effort in Boston is geared to an almost unlimited water supply. No attempt was made to assess the situation if only limited water supplies were available.

GENERAL CONCLUSIONS

1. Many of the shelter buildings could not be protected adequately from within because of building construction and exposure to nearby fire susceptible buildings.

2. If shelter buildings are spaced and constructed so that they offer some resistance to fire, effective fire guard activity would be possible; heavy fallout and fire susceptible buildings would make fire guard activity less effective.

3. Fallout shelters in office buildings and schools in the Boston area do not generally provide adequate protection from a spreading fire. The underground shelters (subway system, etc.) offer better protection from fire but adequate ventilation must be insured.

4. Structural characteristics, building spacing, and materials used in siding, roofing, and general construction are major factors in considering whether or not an area would be defensible if multiple ignitions occurred. Building exteriors have a pronounced effect on fire spread and development.

5. Structural fires spread relatively slowly into the wind so that freeways or even wide streets may halt the spread of fire to a large extent.

6. Some control effort is needed to stop an urban fire moving with the wind except for all but the very widest of fire breaks. Expressways may be inadequate due to the transport of fire brands, particularly if the fire reaches the break unchecked.

7. If multiple ignitions occurred in any of the boroughs where the study fires were located, the entire communities would be threatened - in fact, the area probably would have to be "written-off".

8. If many fires start simultaneously the fire service personnel indicated that they would attempt selective control and sacrifice some areas that could not be defended.

9. Fallout shelters should be risk-rated for fire vulnerability so pre-emergency planning could identify which shelters might be defended from fire and which would have to be evacuated.

10. In pre-emergency planning, the Boston Fire Service emphasized the need to expand on the existing organization to meet emergencies of unpredictable proportions.

11. The successful use of mobile hand lines, rather than stationary master streams, on some fast spreading Boston fires may indicate a need to adapt this tactic to handling multiple small fires in other areas.

RECOMMENDATIONS

1. Education in the effects of nuclear weapons, particularly fallout, is needed for both public officials and the general public. Educational programs should be designed to meet expected occurrences, i.e. the fire problem resulting from nuclear attack on the city of Boston, in addition to blast and fallout.

2. The threat of fire resulting from a nuclear attack on Boston emphasizes the need for developing a system of rating fallout shelters for fire vulnerability. This fire risk rating for each shelter facility would permit early recognition of hazardous shelter spaces.

3. Continue to develop a decentralized system of fallout shelters that provide for maximum fallout and fire protection both from without and within. This shelter capacity is needed in the vicinity of peoples' homes and would mean utilizing more residences or other buildings having a relatively low shelter capacity.

4. Cities and communities should develop a plan that clearly defines the responsibilities for evacuation and rescue for various levels of emergencies - including nuclear attack.